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PROCEEDINGS
AFOSR-FJSRL SYMPOSIUM-WORKSHOP
ON
AIR FORCE BASIC RESEARCH IN CIVIL ENGINEERING

UNITED STATES AIR FORCE ACADEMY, COLORADO
22-24 February 1978

By

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July 1978

Prepared for

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During 22-24 February 1978 a symposium-workshop was held at the USAF Academy for the purpose of identifying and clarifying Air Force requirements for basic research in civil engineering and environmental quality. This informal proceedings summarizes the presentations made by representatives of Air Force agencies with active programs of civil engineering and environmental quality R&D. Also, it summarizes the conclusions and recommendations of workshops conducted in four areas of interest: 1) Nuclear Weapons Effects Analysis; 2) Civil Engineering Readiness; 3) Environmental Quality;

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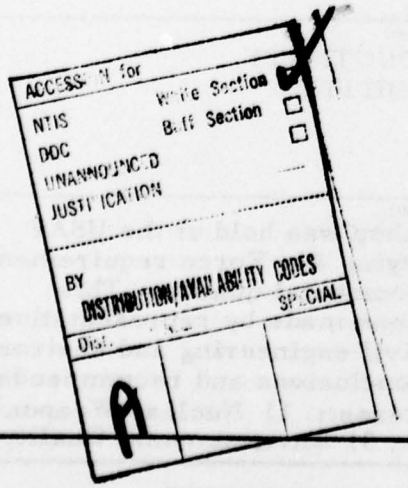
and 4) Civil Engineering Productivity and Livability.



PREFACE

The Air Force Office of Scientific Research (AFOSR) is the single manager of the Air Force's basic research program and the primary Air Force agency for the extramural support of fundamental research. AFOSR awards grants and contracts for research in areas relevant to Air Force needs on the basis of unsolicited proposals originating from investigators in areas of their own choosing.

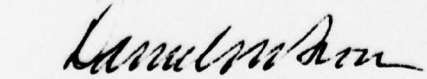
The author is a Resident Research Fellow in the Directorate of Aerospace Sciences at AFOSR, where his assignment includes reviewing the Air Force mission in civil engineering and recommending areas of basic research which will support that mission. In furtherance of that effort, the symposium on basic research in civil engineering was authorized for the purpose of identifying and clarifying research objectives in these areas.

Credit is owing to many individuals who made the meeting a successful one. Representatives of the cosponsoring and supporting agencies who made the formal presentations and conducted the workshops are identified by name and agency in the text, and it is their collective effort which translated the symposium plan into a worthwhile reality.

Special thanks are extended to Lt Gen Kenneth L Tallman, Superintendent, United States Air Force Academy, for making available the excellent conference facilities at the Academy, and to Janet Shea, Conference Coordinator, Directorate of Conferences, United States Air Force Academy, who handled local arrangements with unfailing dependability and professional competence.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS) for availability to the public, including foreign nations.

This technical report has been reviewed and is approved for publication.



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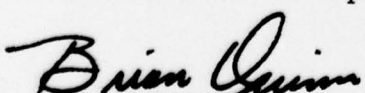

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INTRODUCTION

AFOSR

The Air Force Office of Scientific Research (AFOSR) is the single manager of the Air Force research program and the primary Air Force agency for the extramural support of fundamental scientific research. AFOSR and the various Air Force R&D laboratories are organized under the Director of Science and Technology, Air Force Systems Command.

AFOSR awards grants and contracts for research in areas of science and engineering relevant to the needs of the Air Force. Research is selected for support from unsolicited proposals originating from scientists investigating problems of their own choosing, involving the search for new knowledge and the expansion of scientific principles. Selection criteria include the potential for improving Air Force operational capabilities, originality, scientific merit, qualifications of the investigator, adequacy of facilities or equipment, and reasonableness of the proposed budget.

Detailed requirements for preparing and submitting research proposals are contained in the brochure Proposer's Guide to the AFOSR Research Program, available on request from AFOSR/PKO, Bolling AFB, DC 20332. Prior to submission, investigators should determine AFOSR's possible interest by contacting an Air Force scientist or engineer associated with the technical area in question. Technical personnel and their areas of interest are listed in the US Air Force Research Directory, also available from AFOSR/PKO.

Research requirements of the Air Force are identified in the publication Air Force Systems Command Research Planning Guide (Research Objectives). This document is available only through the National Technical Information Service, US Department of Commerce, Springfield, Virginia 22161 (order number ADA 029310; price $10.50 paper, $2.25 microfiche; price subject to change without notice).

Air Force Civil Engineering Research

The Directorate of Aerospace Sciences (AFOSR/NA) has been assigned the responsibility to determine what, if any, research is required in support of the Air Force civil engineering mission. The author is a Resident Research Fellow at AFOSR/NA, where his assignment includes reviewing the Air Force mission in civil engineering, identifying requirements for civil engineering research, formulating research objectives and recommending a specific program.

During the period July-October 1977 the author visited several Air Force and other DoD agencies whose programs relate to Air Force civil engineering. He reviewed a substantial body of the DoD civil engineering literature and attended service-wide reviews of R&D in civil engineering and environmental quality.

Following these activities civil engineering research objectives (ROs) were drafted and circulated to appropriate Air Force R&D agencies for review and comment. These draft ROs were provided to symposium participants and, along with other inputs from speakers and workshop leaders, provided a basis for the workshop sessions which ensued.

Symposium Plan

A symposium plan, announcement and preliminary program were developed in cooperation with the cosponsoring and supporting agency personnel. A symposium proposal was submitted to and approved by the AFOSR Director and the USAFA Superintendent pursuant to AFR 80-43.

Announcements and preliminary programs were sent to 1) Air Force agencies with civil engineering R&D activities, 2) other DoD agencies with related programs, 3) heads of civil engineering departments at United States colleges and universities, and 4) selected federal agencies with related programs.

Symposium Objectives

The main objective of the symposium was to provide a forum for the identification and clarification of the need for a basic research program in support of Air Force civil engineering.

Presentations by representatives from the supporting agencies were planned to identify those problems to which research results would apply and to indicate areas of potential payoff from these results. Also, these presentations would identify the technical personnel whom investigators might contact to determine Air Force interest in and applications for their proposed research.

The workshops were planned to provide for an interchange of ideas among the participants in an open forum which focused on one particular subarea of civil engineering. Each workshop leader was free to manage his group in the manner he felt to be appropriate.

Finally, it was intended that the symposium provide visibility for Air Force research needs in civil engineering in order to improve coordination among the federal agencies involved and to stimulate involvement by the academic research community through the submission of unsolicited proposals to AFOSR.

Announcement, Program and Attendance

The symposium announcement, final program and a list of participants are attached for reference as Appendix A. Some 81 persons attended, including 35 Air Force personnel, 34 representatives of colleges and universities, 8 from other DoD agencies, 1 from another federal agency and 5 from private R&D firms.

SCHEDULED PRESENTATIONS

The following will summarize only briefly the topics covered by each speaker and their points of emphasis.

Introductory Session

The opening session was moderated by the writer, who began by welcoming those in attendance.

Colonel Wallace E Fluhr, Head of the Department of Civil Engineering, Engineering Mechanics and Materials at the United States Air Force Academy, welcomed the assembly on behalf of the Academy and his Department. He briefly described the mission and scope of his Department and the role of its faculty and students in Air Force research.

Colonel Merle D Bacon, Commander, Frank J Seiler Research Laboratory (FJSRL), welcomed the participants on behalf of the Seiler Lab, and described its role as a Detachment of AFOSR located at the Air Force Academy. FJSRL performs inhouse research in areas of aerospace mechanics, applied mathematics and chemistry, and provides a means to involve Academy faculty and cadets in Air Force R&D.

Next, Dr William L Lehmann, Director of the Air Force Office of Scientific Research and, as such, single manager of the Air Force research program, presented the keynote address. He described AFOSR's role in providing the scientific basis for new technology necessary to create and maintain technological military superiority and to ameliorate the problems which face today's Air Force. He emphasized the long-range nature of Air Force research, explaining that today's research results that pay off will only do so after a protracted development process that may require five to ten years from discovery to operational utility.

Dr Lehmann discussed the military role of science and technology in terms of the cyclical process shown in Fig 1. Science and technology affect the environment in which a military force structure exists, provide the options from which plans and new concepts are formulated to deal with changing problems, and afford the means for development and acquisition of new systems to alleviate these problems.

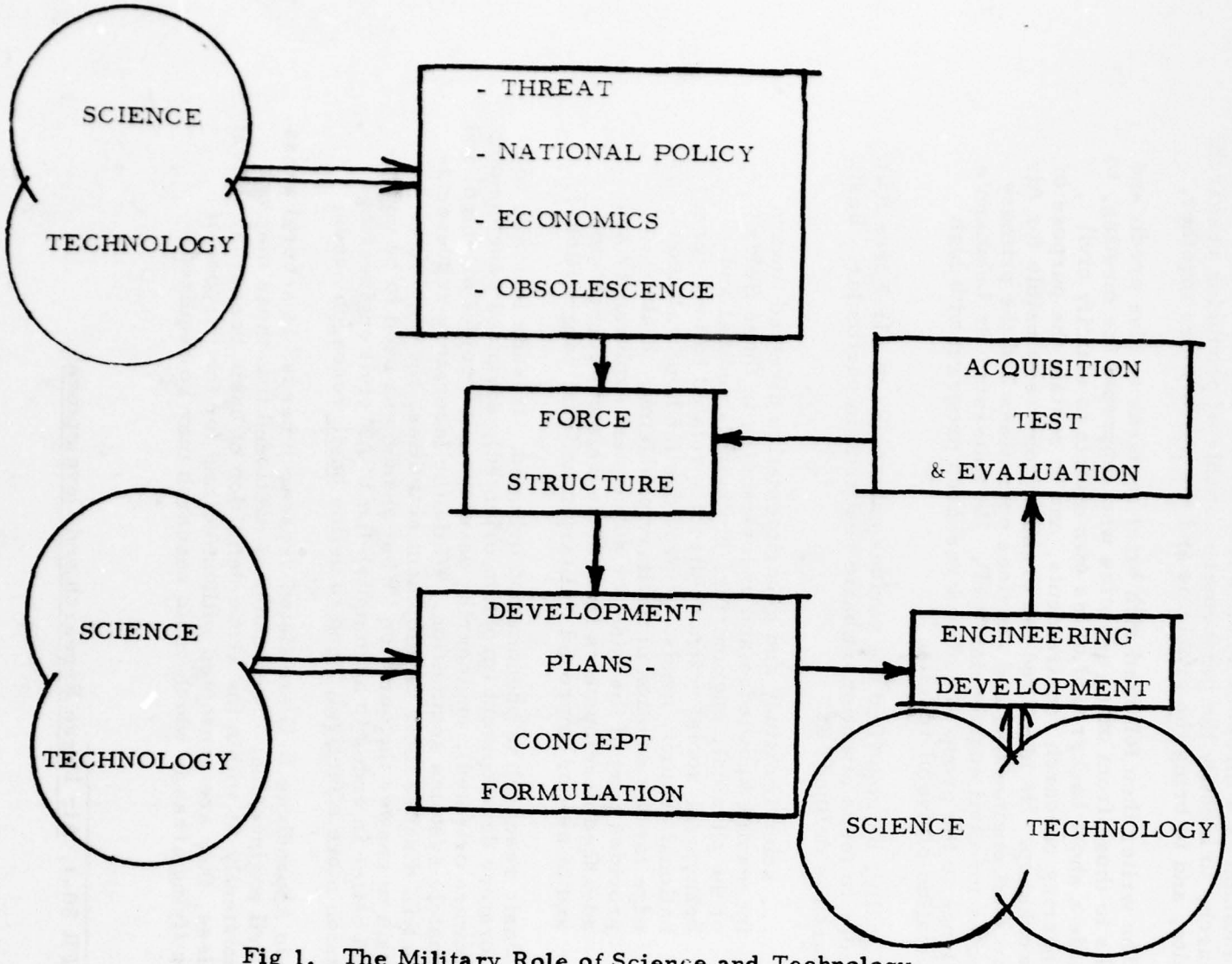

Fig 1. The Military Role of Science and Technology

The research manager's role was characterized by Dr Lehmann as a threefold one; to identify the problems amenable to research, to identify the performers capable of producing research results, and to bring the problems and the performers together.

The writer then followed with brief remarks to give credit and thanks to those from other agencies who supported the meeting, to provide a short background of his own efforts to identify civil engineering research requirements, and to restate the purpose of the workshop. He identified the organizations responsible for Air Force civil engineering and services operations and the primary agencies for civil engineering R&D. He reiterated Dr Lehmann's challenge to the group to define a research program with high expectation of useful results.

Finally, he identified the various categories of Air Force R&D in order to focus attention on basic research in particular. Basic research is defined* as

> ... scientific study and experimentation directed toward increasing knowledge and understanding in those fields of the physical, engineering, biological-medical and behavioral-social sciences directly related to long-term national security needs. It provides fundamental knowledge for the solution of military problems. It also provides part of the base for subsequent exploratory and advanced developments in Defense-related technologies and of new or improved military functional capabilities...

Basic research is phenomenon oriented. It leads logically to exploratory development (problem oriented), advanced development (hardware oriented), engineering development (project oriented) and ultimately systems acquisition. While the laboratory representatives will discuss their development activities, the objectives remain to answer the question "What phenomena need to be understood better in order to accomplish the USAF civil engineering mission more effectively" and to define basic research needs.

In Appendices B-G are listed "research needs" in several areas of civil engineering. The reader is cautioned that these may not consistently fit within the above definition of basic research. Nevertheless, they are presented without editing for the purpose of identifying areas in which basic research may be required.

*AFR 80-1, Air Force Research and Development

Civil and Environmental Engineering Development

Following a short break, Col Joseph S Pizzuto was introduced to moderate the morning's second session. Colonel Pizzuto is Commander, Det 1, HQ ADTC, which is the Civil and Environmental Engineering Development Office (CEEDO), located at Tyndall Air Force Base, Florida.

Colonel Pizzuto described the CEEDO mission, which is research, development, testing and evaluation in civil and environmental engineering. Also, CEEDO is the USAF laboratory focal point for environmental quality technology. The CEEDO organization in shown in Fig 2, and comprises separate directorates in Environics and Civil Engineering.

Environmental Quality R&D - Maj Peter A Crowley, Director of Environics, described the Air Force Environmental Quality R&D program in terms of management concepts and program content.

As the Air Force Systems Command (AFSC) laboratory focal point for environmental quality R&D, the Directorate of Environics coordinates and monitors R&D efforts in this area among some 10 AFSC agencies throughout the country. The Directorate also monitors related R&D efforts in other federal agencies and military services. CEEDO is the lead USAF laboratory for environmental quality R&D.

Based on complex and interrelated requirements stemming from federal/state/local laws, executive orders, DoD directives, Air Force Regulations, etc., the environmental quality program has developed along four thrust areas:

- Environmental and health effects
- Monitoring and transport mechanisms technology
- Environmental management, assessment and planning
- Source reduction, control and treatment technology

Supporting efforts exist within the various AFSC laboratories according to their unique capabilities and specific technical areas of emphasis.

Major Crowley highlighted the following as research needs in the area of environmental quality:

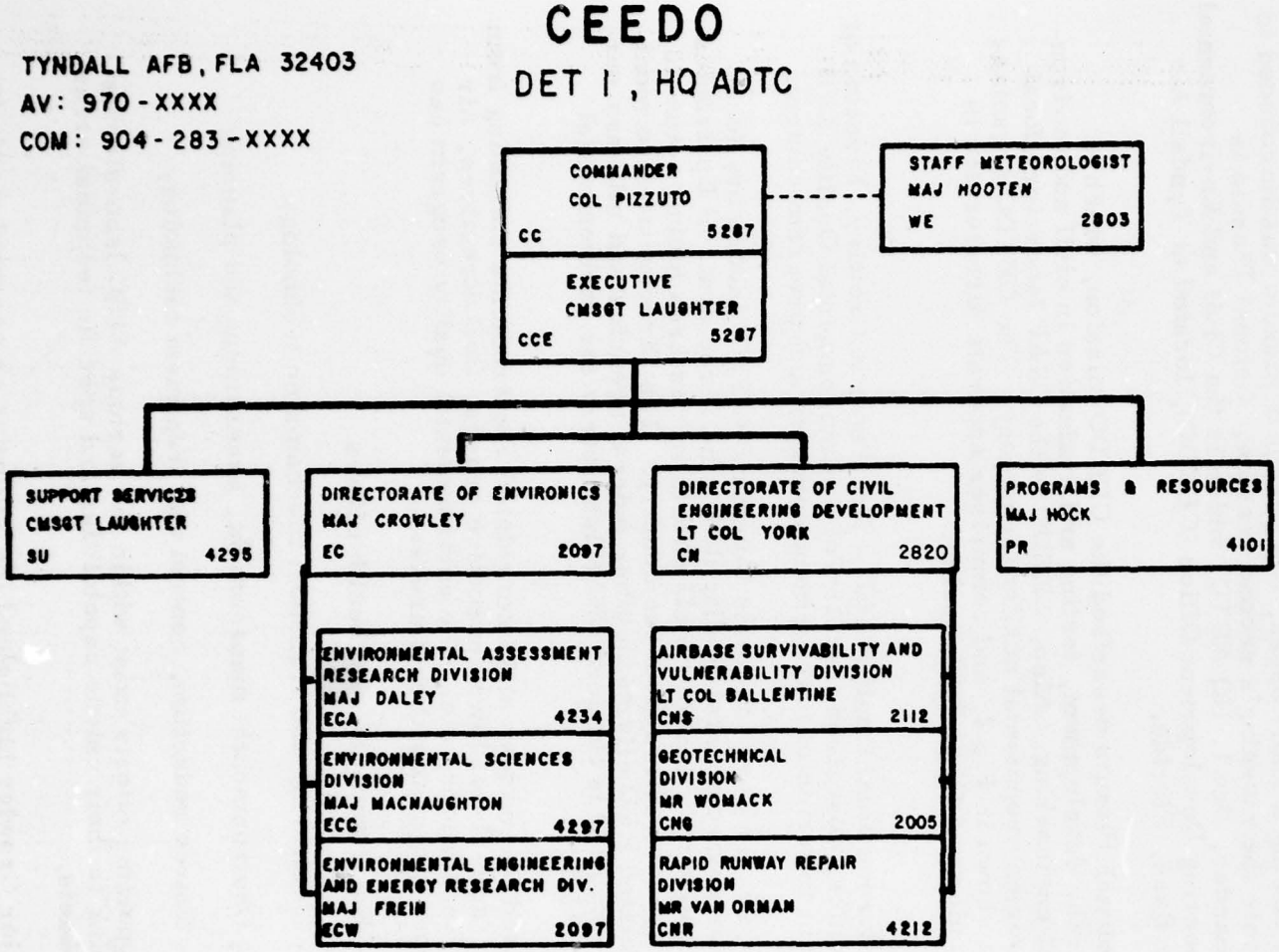

Fig 2. CEEDO Organization

- Toxicology and pathology of Air Force chemical propellants and materials

- Radio frequency radiation health and environmental effects

- Environmental noise modeling and monitoring technology

- Monitoring and modeling of the stratospheric environment

- Environmental fate and effects of Air Force chemicals, propellants and materials

- Environmental measurement and monitoring techniques

- Environmental assessment techniques

- Air pollution control: stationary and mobile sources

- Abatement, control, treatment and disposal of Air Force wastes

- Comprehensive planning and management for Air Force operations

- Resources conservation and recovery technology

Facilities Energy R&D - Maj Emil Frein, Deputy Director of Environics and Chief of the Environmental Engineering and Energy Division, spoke next of the CEEDO program in facilities energy R&D. Major thrusts in that area include:

- Energy recovery

- Energy conservation and monitoring

- Alternate energy sources for remote sites

Research is needed in support of:

- Alternate energy systems for remote sites

- Energy storage systems

- Energy recovery systems

More specific information concerning research needs in the areas of environmental quality and energy is contained in Appendix B.

Civil Engineering R&D - Lt Col Guy P York, Director of Civil Engineering Development, next described the CEEDO effort and characterized research needs in several areas of conventional civil engineering (i.e. civil engineering exclusive of the nuclear blast environment).

As the lead Air Force laboratory for research, development, testing and evaluation in conventional civil engineering, CEEDO monitors related government R&D efforts in the areas of pavements, tactical shelters, fire protection and facility corrosion. Current areas of civil engineering R&D include:

- Aircraft contingency launch/recovery surfaces
- Aircraft pavements
- Airbase survivability/vulnerability (conventional weapons environment)
- Mobile tactical shelters
- Warm fog dispersal
- Fire protection
- Facility corrosion

A more detailed listing of problem areas which may call for civil engineering research is contained in Appendix C.

Nuclear Weapons Effects Analysis

Following the lunch break, Lt Col Stewart W Johnson, Chief, Technology and Applications Branch, Civil Engineering Research Division, Nuclear Technology Office, Air Force Weapons Laboratory, was introduced to moderate the session on nuclear weapons effects analysis.

Lieutenant Colonel Johnson described the mission of the Civil Engineering Research Division, which is located at Kirtland Air Force Base, New Mexico, and which performs research, development, testing and evaluation to determine the effects of airblast and

ground shock produced by nuclear weapons on Air Force systems and facilities. The nature of the problem is indicated schematically in Fig 3. The Division is organized in three branches: Technology and Applications, Simulation, and Test Operations, with the responsibilities shown in Fig 4.

Lieutenant Colonel Johnson explained that, while much of the subsequent discussion would focus on currently active development projects, (e.g. the multiple-aim-point MX system, deep basing concepts) the objective is to identify research areas of generic interest. Current efforts to analyze the MX land mobile trench system, for example, involve nuclear environment issues such as:

- Crater/trench interaction effects
- Trench gas dynamic shock effects
- Trench hardness estimation
- Dust effects
- Structure medium interaction effects
- Entrance/debris interaction
- Radiation effects

Prominent areas for useful research include:

- Siting and nuclear environment definition
- Multiple burst interaction
- Structural response models
- Simulation development
- Instrumentation development
- System assessment methodologies

Geologic Material Dynamics - Capt Joseph H Amend, Project Officer in the Geologic Material Dynamics Section of the Technology and Applications Branch described R&D efforts and research needs in that Section's areas of interest.

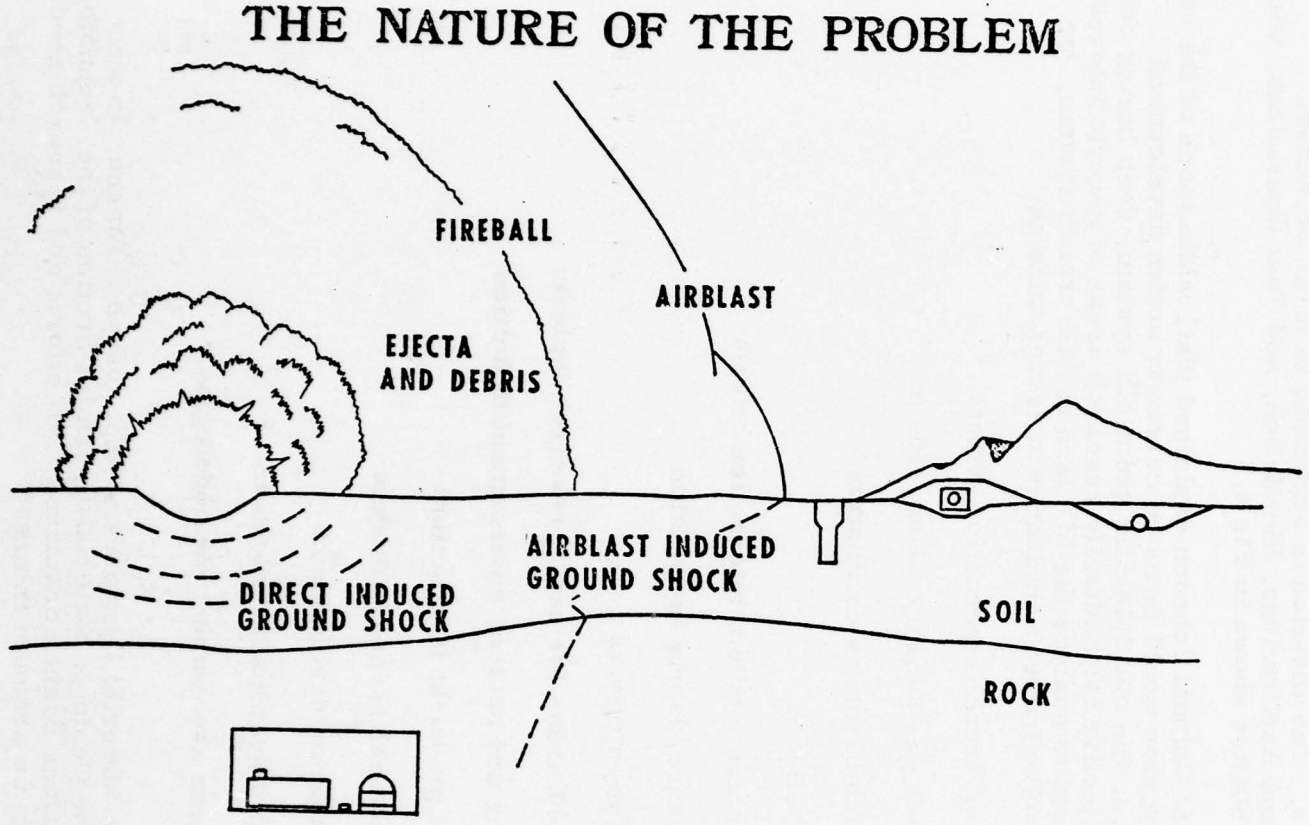

Fig 3. The Nuclear Weapons Effects Environment

CIVIL ENGINEERING RESEARCH DIVISION

CIVIL ENGINEERING RESEARCH

TECHNOLOGY & APPLICATIONS	SIMULATION	TEST OPERATIONS
SITING	REMOTE SENSOR STUDIES	RESOURCE MANAGEMENT
SOIL MEDIA MODELING/ EFFECTS	INSTRUMENTATION	SYSTEMS ENGINEERING
STRUCTURAL RESPONSE TECHNOLOGY	HE SIMULATION DEVELOPMENT	TECHNICAL INTEGRATION
STRUCTURAL FAILURE CRITERIA	DATA ACQUISITION SYSTEMS	CERF
CRATERING	DATA ANALYSIS TECHNIQUES	FIELD TEST PLANNING
AIR BLAST	SENSOR TEST & CALIBRATION	TEST PLANNING
GROUND MOTION	TECHNICAL PHOTO CHARACTERIZATION	

Fig 4. Civil Engineering Research Division (AFWL/DE)

TECHNOLOGY & APPLICATIONS	SIMULATION	TEST OPERATIONS
SHOCK ISOLATION	HE EVALUATION AND CHARACTERIZATION	
MAP BASING ANALYSES		
FUTURE SYSTEMS BASING		
OTHER BASING ANALYSES		
COMPONENT TESTING		
DUST/ICE		
LAMB		

Fig 4. (continued)

Current efforts in geologic material dynamics include:

- Site selection methods and criteria
- Material property determination
- Ground motion analysis
- Multiburst effects analysis
- Deep missile basing concerns

Captain Amend described the cylindrical in-situ test, which is an explosive simulation method designed to provide a data base for estimating in-situ dynamic material properties of various geologic media. He described efforts to develop analytical models of dynamic soil/rock behavior by modeling a partially saturated material as a two-phase (air-soil/water) medium.

Captain Amend listed the following research and technology needs:

- Fundamental soil behavior models
  - two-phase and three-phase models
  - shear effects
- Multiburst effects
- Update Air Force Design Manual
  - site characterization
  - multiburst effects
- MX backfill effects
- Site evaluation criteria and methods
- In-situ rock properties for deeply-based missiles

Structural Dynamics - Lt Travis Waldrip, Project Officer in the Structural Dynamics Section of the Technology and Applications Branch summarized that group's involvement in analytical and experimental efforts to estimate the dynamic response of buried structures and their contents.

These efforts currently relate largely to support of the MX development effort (system assessment studies, component test and evaluation) or to support of other strategic systems, and may be categorized as follows:

- Determination of loads on structures
  - blast pressures on exposed structures
  - earth pressures on buried structures
  - relative motions between structure and surrounding medium
- Behavior of structural elements and systems
  - resistance/deformation relationships
  - structural system response
  - analysis models
- Response of internal equipment
  - shock isolation systems
  - hard-mounted equipment

Current thrusts include developing failure criteria for reinforced concrete and structure-medium interaction effects for buried cylinders. Future efforts are expected to emphasize improved two and three dimensional analysis codes, improved behavior models for both conventional and fiber-reinforced concrete, and improved methods for airblast loads determination.

Lieutenant Waldrip demonstrated the complexity of survivability/vulnerability analysis for strategic systems with the diagram shown in Fig 5, which also shows the experimental and analytical efforts involved and the problem areas to which research efforts might apply.

Simulation Technology - Lt Col Rudolph V Matalucci, Chief of the Development Branch in the Civil Engineering Research Division, described the high energy explosive experimental simulation programs carried out by his Branch.

Since the mid 1960s the Simulation Branch has been involved with research, development, testing and evaluation to simulate the airblast and ground shock effects of nuclear blasts on strategic structures. Present activities deal largely with validation and assessment of the land-mobile MX system, and comprise a variety of facilities capable of simulating yields up to one megaton and overpressures to more than 35 megaPascals.

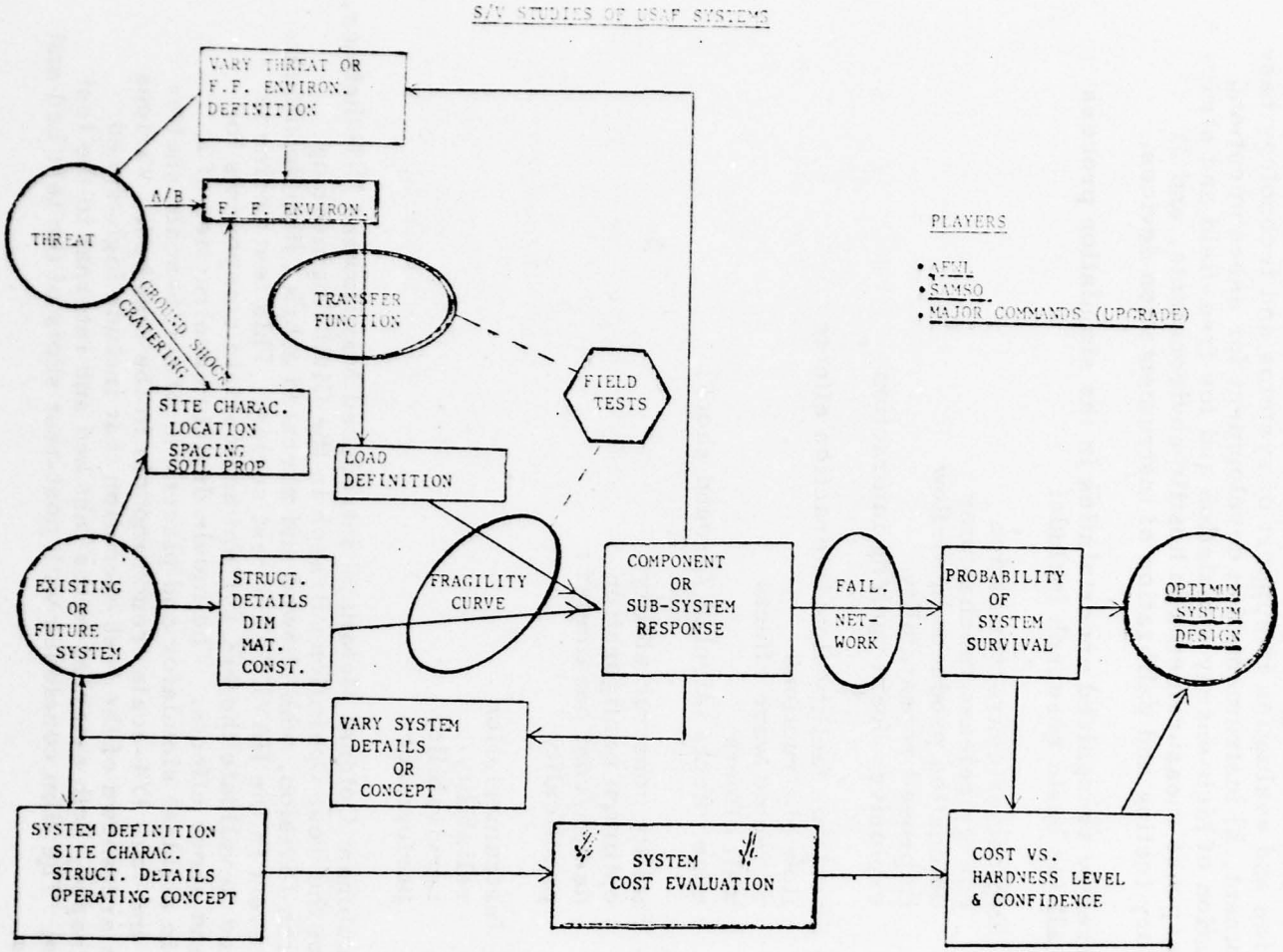

Fig 5. Survivability/Vulnerability Studies of USAF Strategic Systems

Simulation Branch Objectives include 1) high-explosive simulation technology development for airblast and ground motion prediction and evaluation in support of systems and technology base development, 2) instrumentation development for assessment and verification of high-energy simulation and for free-field and structural response measurements in hostile environments, and 3) laboratory testing and calibration of instrumentation devices.

Currently recognized uncertainties in the simulation process which call for basic research include:

- Explosives characterization
  - energy release mechanisms
  - detonation products in airflow
  - improved repeatability
  - explosives-foam packing interaction
- Simulator facility flow interaction effects
  - flow obstructions
  - reflected wave effects
  - wall effects
  - edge effects (airblast/ground shock)
- Facility constructability
  - optimum configuration
  - design/cost parameters
  - practicality
- Instrumentation
  - reliability
  - survivability
  - performance

Lieutenant Colonel Matalucci introduced Maj Howard E Selheimer, Chief of the Test Operations Branch in the Civil Engineering Research Division, who showed and narrated a brief film documenting an event in the HAVE HOST test series. This test series is designed to validate the MX system and certain components for blast and shock effects. The movie depicts construction of a dynamic airblast simulator and placement of a 1/6-scale shelter model and four 1/4-scale trench models in the test bed. Various scenes are shown of the test execution that include high-speed photography, both external to the test bed and internal to the test models. The film concludes with post-test shots of the test bed and models.

A listing of research needs in the nuclear weapons effects analysis area is collected below, in Appendix D.

Base-Level Civil Engineering

Following a short break, Lt Col Sterling E Schultz was introduced to discuss Air Force civil engineering from the perspective of airbase operations and maintenance, and to describe the mission and scope of the Air Force Civil Engineering Center (AFCEC). Lieutenant Colonel Schultz is Director of Environmental Planning at AFCEC, which is also located at Tyndall Air Force Base, Florida.

The Air Force civil engineering mission includes responsibility for Air Force construction operations worldwide, architectural and engineering services, military construction programs, maintenance and repair of real property, maintenance and force management, utilities, fire protection and land use planning. Additional important responsibilities include environmental quality management, engineering readiness programs, energy conservation, corrosion control and pavements management efforts Air Force wide.

AFCEC is organized as shown in Fig 6. The AFCEC mission is to provide Air Force units and activities, including reserve forces, with specialized technical services and planning assistance requiring equipment or knowledge beyond that normally available in the typical major command.

AFCEC is responsible for the development, test, evaluation and implementation of management systems and software for real property, contingency forces, environmental management/planning, and fire protection. AFCEC provides technical assistance to major commands in several areas, including corrosion control, pavement evaluation, show/ice removal, environmental planning, energy conservation, bird-aircraft strike problems, and civil engineering equipment. AFCEC manages the engineering development and field evaluation of materials, systems and techniques in the Air Force civil engineering environment.

Lieutenant Colonel Schultz discussed a variety of currently pressing problems, emphasizing those areas not already covered in the CEEDO presentation. He provided the list of civil engineering R&D requirements included below as Appendix E, which indicates possibly fruitful areas of basic research.

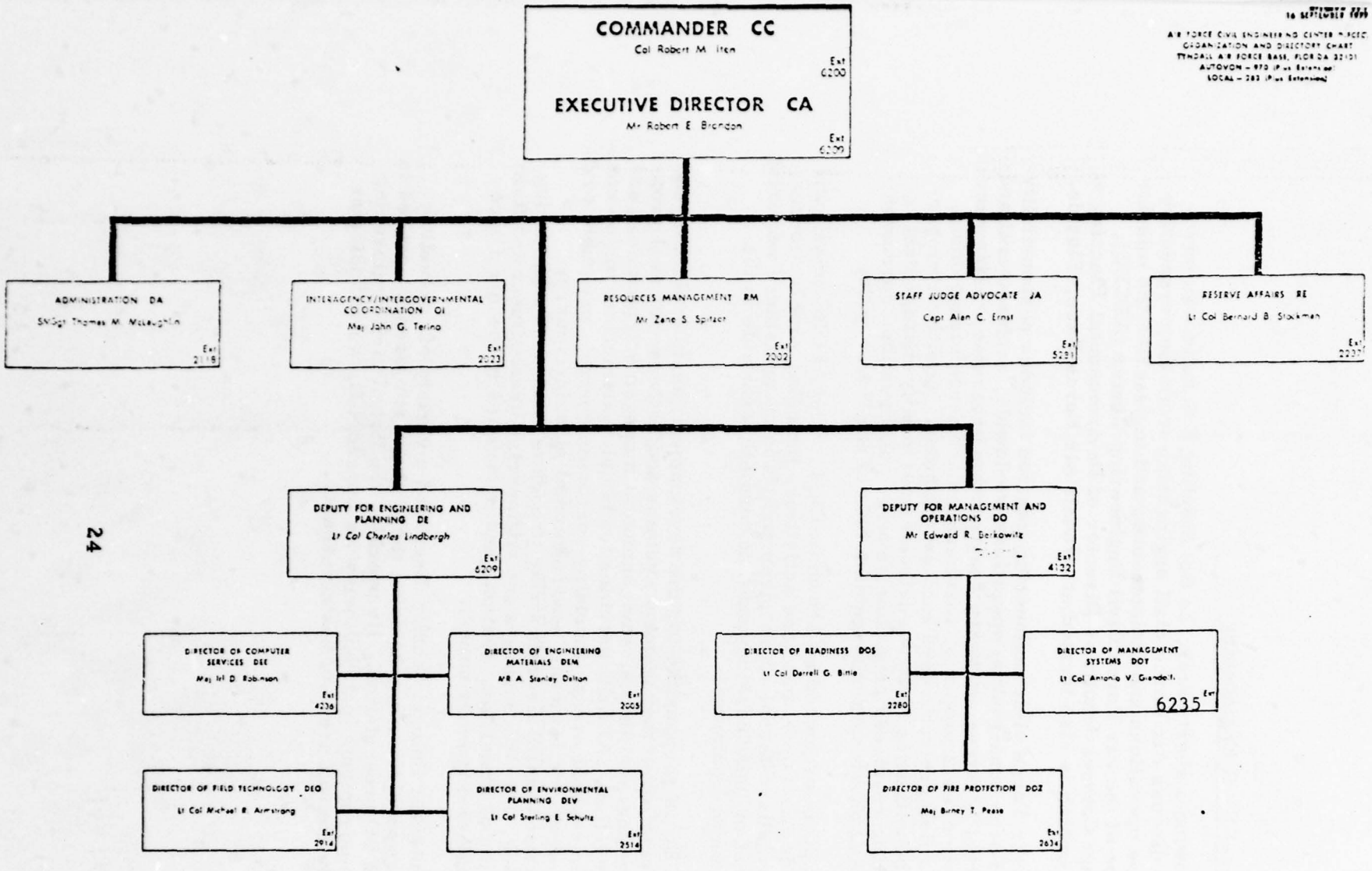

Fig 6. AFCEC Organization

WORKSHOPS

Following a break for dinner, the meeting reconvened in four separate workshop sessions. Each workshop met Thursday evening for two hours and again Friday morning for two hours. Following the Friday workshop sessions, the entire group reconvened for brief summary reports from the workshop leaders.

Each attendee was provided with a copy of the draft research objectives, attached as Appendix F. Workshop topic areas and discussion leaders were:

Environmental Quality and Facilities Energy

- Maj Peter A Crowley, Director of Environics, CEEDO
- Maj Emil Frein, Deputy Director of Environics and Chief, Environmental Engineering and Energy Division, CEEDO

Conventional Civil Engineering

- Lt Col Guy P York, Director of Civil Engineering Development, CEEDO
- Mr Mike Womack, Chief, Geotechnical Division, CEEDO

Nuclear Weapons Effects Analysis

- Capt Harry T Webster, Chief, Structural Dynamics Section, AFWL/DES-S

Productivity, Livability and Management

- Lt Col Robert G Gilbert, Chief, Management Branch, Operations and Maintenance Division, HQ USAF/PRE

The topics discussed in the workshops are sufficiently well covered by the material in Appendices B-G, and will not be repeated here.

SUMMARY AND CONCLUSIONS

On 23-24 February 1978 a symposium-workshop was held at the United States Air Force Academy for the purpose of identifying and clarifying USAF research needs in civil engineering.

Presentations by representatives from various USAF agencies with active programs in different areas of civil and environmental engineering were made to identify the problems to which basic research results would apply and to indicate areas of potentiality high payoff. Workshop sessions were held to provide open discussion focusing on four areas:

Environmental Quality and Facilities Energy

Conventional Civil Engineering

Nuclear Weapons Effects Analysis

Productivity, Livability and Management

These informal proceedings summarize the scheduled presentations and catalog specific basic research needs.

Civil engineering is a broad and syncretic field. The scope of potential Air Force civil engineering research efforts can and should be limited to include only those areas which are Air Force unique; i.e. to exclude areas which are covered by other DoD research programs and by research activities in other Federal agencies. Nonetheless, even with this limitation, a wide range of research opportunities remains.

In the conventional, (non-nuclear) civil engineering area, basic research which leads to new materials and techniques for design, construction, repair and rehabilitation of airfield pavement structures as well as equipment and methods for rapid recovery of bomb-damaged airfield pavements is a critical need.

The Air Force commitment to leadership and excellence in the field of environmental quality presents research opportunities in a number of areas to support the mission of managing and planning programs to protect the environment.

The continuing need to analyze the effects of nuclear weapons on proposed strategic structures and systems calls for research leading to improved understanding of the behavior of geologic media and

structural systems in extreme environments, with emphasis on the development of more realistic analytical models and experimental facilities/equipment.

Air Force civil engineering authorities have responsibility for the operational facilities and living/working environments supporting Air Force programs and personnel. In the face of declining resources (money and manpower) and increasing demands on the system, research is needed in support of planning and management objectives that include improved productivity for Engineering and Services personnel and enhanced livability for Air Force people, both on and off the job.

The need is apparent for a substantial and continuing program of basic research in civil engineering. Problem areas exist which are unique to the Air Force, which are not being studied at a fundamental level by efforts supported by DoD or other federal programs, and which afford an opportunity for basic research with a high expectation of useful and far-reaching results. A capability exists within the civil engineering research community, both within DoD and without, which is not presently being fully utilized for uncovering and exploiting basic phenomena relevant to Air Force civil engineering and environmental quality needs.

To paraphrase the keynote speaker, the AFOSR mission is to identify Air Force problems amenable to research, to identify performers capable of producing useful research results, and to match the performer against the problem in a productive way. Certainly the meeting has helped elucidate numerous areas of potentially fruitful research. Hopefully, it will also help stimulate the next steps in the process of realizing the matchups.

APPENDIX A

Announcement, Program and Attendance

AREAS OF INTEREST
Please indicate one or more

ENVIRONMENTAL PROTECTION
___detection/monitoring/control
___transport/impact mechanisms
___disposal/abatement/recovery
___management/planning

CIVIL ENGINEERING-GENERAL
___airfield pavements
___airbase survivability/vulnerability
___corrosion control
___energy conservation
___equipment/systems

NUCLEAR WEAPONS EFFECTS
___geotechnical survey methods
___soil/rock dynamics
___structure-medium interaction
___structural dynamics
___cratering phenomena
___simulation technology
___construction technology

PLANNING & MANAGEMENT
___management software systems
___productivity-communication
___environmental planning

ANNOUNCEMENT

AFOSR--FJSRL

Symposium
on
AIR FORCE BASIC RESEARCH
in
CIVIL ENGINEERING

US Air Force Academy
Colorado

23-24 February 1978

ANNOUNCING
a two-day symposium-workshop on
AIR FORCE BASIC RESEARCH
IN CIVIL ENGINEERING

WHERE?
US Air Force Academy, CO

WHEN?
23-24 February 1978

OBJECTIVES
1. To identify and describe Air Force activities and research needs in civil engineering;
2. to provide for an interchange of ideas among USAF personnel and the civil engineering research community; and
3. to stimulate the involvement of the academic and industrial research community in the solution of critical Air Force civil engineering problems.

SPONSORING AGENCIES
-Air Force Office of Scientific Research (AFOSR)
Bolling AFB, DC
-Frank J Seiler Research Lab (FJSRL) USAF Academy, CO

For conference information contact Dr Dan Brown
AFOSR/NA
202-767-4937

SUPPORTING AGENCIES
-Civil & Environmental Engineering Development Office (CEEDO)
Tyndall AFB, FL
-Air Force Weapons Laboratory
Civil Engrg Research Div
(AFWL/DE) Kirtland AFB, NM
-Air Force Civil Engrg Center
(AFCEC) Tyndall AFB, FL
-Department of Civil Engrg,
Engrg Mechanics & Materials
USAF Academy, CO
-Directorate of Conferences
USAF Academy, CO

AGENDA
Short presentations on Air Force civil engineering activities and research needs will be followed by workshop sessions in which research objectives for various areas will be explored in detail. These areas are:
-Environmental protection
-Civil engrg development
-Survivability/vulnerability
-Productivity/livability

ACCOMODATIONS
A block of rooms has been set aside in the Sheraton Motor Inn at the Academy South gate. Call 1-303-598-5770 for reservations, and mention the conference for the group rate ($14 s, $16 d). Government personnel are urged to stay at the motel rather than in government quarters at USAFA.

detach here, complete both sides, and mail

PARTICIPATION
Participation is invited by
1. those from academic, industrial & government organizations with active programs of research in civil engineering, planning and management, and
2. personnel from Air Force organizations with interests in civil engineering R&D.
A security clearance will not be required, but foreign nationals will not be admitted.

REGISTRATION
To preregister, detach, complete (both sides) and mail this portion of the brochure, preferably by 1 Feb, to:
AFOSR/NA (Dr Dan Brown)
Bolling AFB, DC 20332

NAME_____

TITLE_____

ORG_____

ADDRESS_____

_____

PHONE_____

US CITIZEN? __YES __NO

No registration fee will be charged. $1.50 will be collected at registration to cover refreshments etc.

AGENDA

AFOSR-FJSRL SYMPOSIUM-WORKSHOP
AIR FORCE BASIC RESEARCH IN CIVIL ENGINEERING

US Air Force Academy, Colorado
23-24 February 1978

22 February	(Wednesday evening)	
1900-2100	Registration: Sheraton Motor Inn	
23 February	(Thursday)	
0745	Bus from Motel/VOQ to Fairchild Hall	
0800	Registration: Fairchild Hall	
0900	Welcome - USAFA	Col Wallace E Fluhr Permanent Professor & Head Dept of Civil Engineering, Engineering Mechanics & Materials, USAFA
0915	Welcome - FJSRL	Col Merle D Bacon, Commander Frank J Seiler Research Laboratory
0930	Keynote Address	Dr William L Lehmann, Director Air Force Office of Scientific Research (AFOSR)
1015	Symposium Objectives	Dr Daniel M Brown, Research Manager, Directorate of Aerospace Sciences (AFOSR/NA)
1030	BREAK	
1100	Civil & Environmental Engineering	Col Joseph S Pizzuto, Commander Civil & Environmental Engineering Development Office (CEEDO)
1115	Environmental Quality	Maj Peter A Crowley, Director Directorate of Environics (CEEDO/EC)

1140	Facilities Energy	Maj Emil Frein, Deputy Director Directorate of Environics (CEEDO/EC)
1205	Civil Engineering	Lt Col Guy P York, Director Directorate of Civil Engineering Development (CEEDO/CN)
1230	Bus to USAFA Officers' Club	
1245	LUNCH	
1345	Bus to Fairchild Hall	
1400	Nuclear Weapons Effects Analysis	Lt Col Stewart W Johnson, Chief Survivability Branch Civil Engineering Research Division, Nuclear Technology Office Air Force Weapons Laboratory (AFWL/DES)
1415	Geologic Material Dynamics	Capt Joseph H Amend, Project Officer, Geologic Material Dynamics Section (AFWL/DES-G)
1440	Structural Dynamics	Lt Travis Waldrip, Project Officer Structural Dynamics Section (AFWL/DES-S)
1505	Simulation Technology	Lt Col Rudolph V Matalucci, Chief Simulation Development Branch (AFWL/DED)
1530	BREAK	
1600	Air Force Civil Engineering Center	Lt Col Sterling E Schultz Director of Environmental Planning Deputy for Engineering & Planning Air Force Civil Engineering Center (AFCEC/DEV)
1730	Bus to Motel/VOQ	

23 February (Thursday evening)

1800 Attitude adjustment: Sheraton Motor Inn

1900 Dinner: Sheraton Motor Inn

2030 Workshop sessions: Sheraton Motor Inn

- Environmental Quality & Facilities Energy

  Maj Crowley
  Maj Frein
  (CEEDO/EC)

- Civil Engineering

  Lt Col York
  Mr Mike Womack, Chief, ACFT Operational Surfaces Division (CEEDO/CNO)

- NWE Analysis

  Capt Harry T Webster, Chief, Structural Dynamics Section (AFWL/DES-S)

- Productivity, Livability & Management

  Lt Col Robert G Gilbert, Chief, Management Branch, Operations & Maintenance Division, Directorate of Engineering & Services (HQ USAF/PREMA)

2230 BREAK

Bus to VOQ

24 February (Friday morning)

0800 Bus from Motel/VOQ to Fairchild Hall

0830 Workshop Sessions (continued) Fairchild Hall

1030 Summary Reports & Discussion Fairchild Hall

1200 Bus to USAFA Officers' Club

1215	LUNCH	
1315	Bus to Motel/VOQ	
1330	Executive Session	**Speakers & Workshop Leaders**

AIR FORCE CIVIL ENGINEERING RESEARCH SYMPOSIUM
22-24 February 1978

PARTICIPANTS

NAME	ORGANIZATION
Joel Abrams	University of Pittsburgh
Steven Abt	Colorado State University
Joseph Amend	Kirtland AFB
Charles Babendreier	NSF
Roy Ball	University of Tennessee
James Beason	Kirtland AFB
William Berry	AFOSR
Robert Blanton	Human Sciences Research
Carl Bodley	Martin Company
Joel Bradshaw	Kirtland AFB
Dan Brown	AFOSR
Earl Brown	Duke University
Delmar Calhoun	CE Research Facility
Stanton Chang	Kirtland AFB
Wayne Charlie	Colorado State University
Robert Y K Cheng	Old Dominion University
J Choromokos, Jr	IIT
Robert Dinnat	US Army Construction Engineering Research Laboratory
Peter Crowley	CEEDO
Braja Das	South Dakota State University
Paul Dolter	AFIT
John Dow	University of Colorado
James Eri	AFOSR
W J Flathau	USAE Waterways Exp Station
Larry Feeser	Syracuse University
Chuan Feng	University of Colorado
Robert Frank	Kirtland AFB
Alfred Fregly	AFOSR
Emil Frein	CEEDO
Donald Gage	Norton AFB
Gary Ganong	Kirtland AFB
Robert Gilbert	HQ USAF/PRE
T Allan Haliburton	Oklahoma State University
Ronald Hutchinson	USAE Waterways Exp Station
John Jackson	USAE Waterways Exp Station
Roy Johnson	Auburn University
Stewart Johnson	Kirtland AFB
Anant Kukreti	University of Colorado

NAME	ORGANIZATION
John Lamb	Wayne State University
George Lee	State University of New York at Buffalo
William Lehmann	AFOSR
Gerald Leigh	University of New Mexico
William Mason	AFIT
Rudolph Matalucci	Kirtland AFB
Laurence Melzer	Kirtland AFB
David Menicucci	RDA
Edwin Mixon	HQ USAF/PRE
Paul McNickle	Kirtland AFB
George Morosow	University of Colorado
Dennis Nagy	Princeton University
John Nielsen	CE Research Facility
Thomas Paez	University of New Mexico
Joe Pizzuto	Tyndall AFB
Maynard Plamondon	Kirtland AFB
Brian Quinn	AFOSR
Michael Reed	Kirtland AFB
James Reynolds	Utah State University
Charles Roeder	University of Washington
James Dale	USAE Waterways Exp Station
Robert Schiffman	University of Colorado
Sterling Schultz	AFCEC, Tyndall AFB
J R Sculley	VMI
Howard Selheimer	Kirtland AFB
Warren Shaw	NCEL
Sidney Shore	University of Pennsylvania
Ken Siegenthaler	USAFA
Donald Silva	RDA
Jimmy Smith	Texas Tech University
John Storm	HQ USAF/PRE
Alvin Strauss	University of Cincinnati
Oren Strom	Wright-Patterson AFB
Robert Sweazy	Texas Tech University
Thomas Tarpy	Vanderbilt University
Randolph Thomas	Pennsylvania State University
Theodore Thomas	Battelle
Travis Waldrip	Kirtland AFB
Harry Webster	Kirtland AFB
James Wight	University of Michigan
L M Womack	CEEDO
Guy York	CEEDO

APPENDIX B

Environmental Quality and Energy Research Needs

UNITED STATES AIR FORCE

ENVIRONMENTAL QUALITY AND ENERGY RESEARCH NEEDS

Presented at

AFOSR/FJSRL Symposium

Air Force Basic Research in Civil Engineering

23-24 February 1978

1. Toxicology and Pathology of Air Force Chemicals, Propellant, and Materials

Contact: Dr Antonne A Thomas, AMRL/TH
Wright-Patterson AFB OH 45433
(513) 275-5740

a. Develop Three Tier Screening Concepts for:

Molecular Discriminants
Microbiotic Discriminants
Macrobiotic Discriminants

b. Develop Scaling Principles for:

Target Organ Identification
Sequestration/Elimination
Mechanism of Action - Acute/Chronic

c. Define Dosimetry Concepts

2. Radio Frequency Radiation (RFR) Health and Environmental Effects

Contact: Col William Godden, AMD/RDR
Brooks AFB TX 78235
(512) 536-3681

and/or

Mr John E Pickering, USAFSAM/RZ
Brooks AFB TX 78235
(512) 536-3414

a. Develop Scaling Principles for:

Target Organ Identification
Energy Coupling Dissipation
Mechanisms of Action
Acute/Chronic - Thermal/Athermal

b. Develop Predictive Models

Critical Parameter Dependence

c. Define Dosimetry Concepts

3. Refinement of Noise Modeling and Monitoring Technology

Contact: Dr Henning E G Von Gierke, AMRL/BB
Wright-Patterson AFB OH 45433
(513) 275-3603

a. Develop Psychoacoustic Predictors of Cumulative Noise Response

b. Develop Noise Data Base for Helicopters

c. Determine Effects of Terrain, Vegetation, Ground Cover and Man-Made Structures on Aircraft Noise Propagation

d. Define Effects on Noise Models WRT Transition Region Between Ground-to-Ground and Air-to-Ground Propagation Conditions

e. Define Effects of Aircraft Acceleration on the Generation of Noise During Takeoff and Landing Roll

f. Verify "Penalties" Used in Noise Control Predictions:

Nighttime
Ground Run-up

g. Validate Predictions of Noise Levels in NOISEMAP

h. Refine Monitoring Techniques for NOISECHECK

4. Measurement and Modeling of Stratosphere

Contact: Dr Earl Good, AFGL/TBC
L G Hanscom Fld MA 01731
(617) 861-3091

a. Develop Monitoring Techniques

b. Define Stratospheric Environment

c. Develop Descriptive Models for Stratosphere

d. Define Effect of Water Vapor in Stratosphere

5. Environmental Fate and Effects of Air Force Chemicals, Propellants, and Materials

Contact: Fate and Chemistry
Maj Michael G MacNaughton, Det 1 HQ ADTC/ECC
Tyndall AFB FL 32403
(904) 283-4297

Effects
Maj C B Harrah, AMRL/THE
Wright-Patterson AFB OH 45433
(513) 275-3364

a. Define Effects of Chemicals, Propellants, Materials on Flora and Fauna

b. Define Chemical Mechanisms of Transport in Aqueous and Air Environment

c. Define Photochemical Reactivity of JP-4/5/8 and Alternate Fuels

d. Identify and Quantitate All By and Intermediate Products of Amine Based Fuels

e. Identify and Quantitate All Products of Scrubbing, Absorption, and Combustion of Amine Based Fuels

f. Determine Environmental Fate of Beryllium

g. Define Mechanisms of Chlorination and Ozonation of JP-4/5/8 and Alternate Fuels Resideuals in Water

h. Define Effects of Weathering/Storage of HC Fuels on Atmospheric Photochemistry and Aquatic Chemistry

6. Environmental Measurement and Monitoring Techniques

Contact: Maj Michael G MacNaughton, Det 1 HQ ADTC/ECC
Tyndall AFB FL 32403
(904) 283-4297

a. Develop Inexpensive, Accurate, Specific, Portable, Ambient, OSHA, Source Instruments Which Continuously Measure, Store, and Analyze Data Automatically for:

HC, NO_x, CO, O_3
Particulate Analyzer for Mass and SAE Distribution
Aqueous HC and Halocarbons
Waste Treatment Parameters, e.g. BOD, etc.

b. Develop Optical Techniques for Ambient and Source Pollutants for HC, NO_x, CO, O_3

c. Characterize Probe Effects and Develop Design for Aircraft Exhaust Measurement

7. Environmental Assessment Techniques

Contact: Maj Peter S Daley, Det 1 HQ ADTC/ECA
Tyndall AFB FL 32403
(904) 283-4234

a. Develop, Refine, and Perform Sensitivity Analyses for Models:

Air Pollution
Water Pollution
Toxic Spills

b. Improve Theory for Dispersion Predictions Close (< 100m) to Source, for Long (> 10km) Distances, and for Complex Geographical Situations

c. Develop and Refine Computerized Environmental Assessment Techniques

d. Develop Transportation Models for Land Use

8. Air Pollution Control: Stationary and Mobile Sources

Contact: Maj Peter S Daley, Det 1 HQ ADTC/ECA
Tyndall AFB FL 32403
(904) 283-4234

a. Develop Methods to Control Particulate Effluents from Dilute, High-Volume Gas Streams, such as Test Cells

b. Develop Low Cost, Efficient Controls for Hydrocarbons Emissions from Fuel Storage Tanks

c. Develop Control Techniques for Aircraft Emissions with Minimal Impact on Aircraft Performance

d. Define Particle Forming Mechanisms in Turbine Engine Combustors to Enable Design of Low Smoke Engines for New Fuels, such as JP-8 and Shale Oil Derived Fuels

9. Abatement, Control, Disposal, and Treatment of Air Force Wastes

Contact: Maj Emil C Frein, Det 1 HQ ADTC/ECW
Tyndall AFB FL 32403
(904) 283-2097

a. Develop Techniques to Efficiently Treat Air Force Wastes from Electrochemical, Photochemical, and Other Industrial Operations, e.g.

Cyanide Wastes from Electroplating Operations
Aqueous Film Forming Foam (Fire-Fighting Agents)
Optimization of Industrial Waste Treatment Systems
Efficiency
Energy Consumption
Amine Based Fuel Wastes

10. Comprehensive Planning and Management for Air Force Operations

Contact: Maj Peter S Daley, Det 1 HQ ADTC/ECA
Tyndall AFB FL 32403
(904) 283-4234

a. Develop Usable Methodology Which Will be Used for:

Comprehensive Planning for Air Force Ranges
Comprehensive Planning for Air Force Bases
Natural Resources Management

b. Develop Remote Sensing Techniques for Natural Resources Management and Land Use Planning

c. Develop New Ways to Identify Presence of Birds in the Airport Vicinity

d. Develop New Methods to Identify Important Environmental Aspects of Large Land Tracts Without Detailed, Time-Consuming, Ground Truth Surveys of the Entire Area

11. Resources Conservation and Recovery Technology

Contact: Maj Emil C Frein, Det 1 HQ ADTC/ECW
Tyndall AFB FL 32403
(904) 283-2097

a. Develop Techniques for:

Water Supply and Reuse
Effects of Recycled Waters on Aircraft Parts and Surfaces
Standards and Criteria for Sub-Potable Water Reuse
Solid Waste Management
Characterize Combustion Products from RDF
Recovery and Reuse of Materials, Chemicals, etc.
Aqueous Film Forming Foams (Fire-Fighting Agents)

12. Alternate Energy Sources for Remote Sites

Contact: Maj Emil C Frein, Det 1 HQ ADTC/ECW
Tyndall AFB FL 32403
(904) 283-2097

a. Develop Alternate Energy Sources for Remote Sites

b. Provide Total Utilities for Remote Sites
Batteries
Thermal
Mechanical
Hydrogen Storage
Controls for Interfacing Alternate Energy Sources with Existing System

13. Energy Recovery

a. Develop Techniques for Recovery of Waste Heat Energy
Jet Engine Test Cells
Air Compressor Systems
Diesel Generators

APPENDIX C

Conventional Civil Engineering Research Needs

1. CONTINGENCY LAUNCH & RECOVERY SURFACES

A. BOMB DAMAGE REPAIR (BDR)

- TOTAL SYSTEMS TO RAPIDLY REPAIR BOMB-DAMAGED PAVEMENTS (EUIPMENT AND MATERIALS)

- FAST-SETTING, ALL-WEATHER, HIGH-STRENGTH BDR CAP MATERIALS THAT WILL PERFORM WITH WET AGGREGATE FROM -25 TO 125°F, AND CAN BE EASILY HANDLED IN LARGE VOLUMES

- ONE MATERIAL WITH LOW HANDLING TO FINISHED VOLUME RATIO FOR RAPID BACKFILL OF CRATERS, AND SUFFICIENT STRENGTH TO HANDLE A/C OPERATIONS

- RAPID COMPACTION SYSTEMS/METHODS FOR EJECTA AND BACKFILL

- RAPID METHODS/SYSTEMS TO REMOVE UPHEAVED PAVEMENT

- RAPID METHODS TO STABILIZE BACKFILL MATERIALS FROM BOMB EJECTA

B. POST ATTACK

- RAPID SYSTEMS TO ASSESS BOMB DAMAGE OF TOTAL AIRFIELD AFTER ATTACK
- RAPID SYSTEMS TO DISPOSE AND CLEAR AIRFIELD OF UNEXPLODED ORDNANCE AFTER ATTACK

C. ALTERNATE LAUNCH SURFACES

- RAPID INEXPENSIVE METHODS OF STABILIZING LARGE AREAS OF SOIL, PARTICULARLY CLAYS, SUITABLE FOR A/C OPERATIONS
- MATERIALS THAT CAN BE RAPIDLY SPRAYED ON SURFACE TO CONSTRUCT INSTANT RUNWAYS
- DESIGN CRITERIA FOR ALTERNATE LAUNCH SURFACES USING CONVENTIONAL MATERIALS

D. SURFACE ROUGHNESS

- PAVEMENT SURFACE ROUGHNESS CRITERIA FOR EACH TACTICAL AIRCRAFT (SURFACE UPHEAVAL, SETTLEMENT, TYPE MATERIAL)

- EFFECTS OF AM-2 MAT PATCHES ON TACTICAL AIRCRAFT (PATCH HEIGHT, LENGTH, SPACING VS AIRCRAFT SPEED, WEIGHT, CONFIGURATION)

- COMPUTER SIMULATION CODES TO ACCURATELY PREDICT A/C PERFORMANCE ON ROUGH SURFACES

2. AIRBASE SURVIVABILITY

- STRUCTURAL ANALYSIS OF 3RD GENERATION SHELTER TO DETERMINE FAILURE POINTS FROM OVER-PRESSURE, IMPULSE AND GROUND SHOCK LOADINGS
- TOTAL AIRBASE SYSTEM TO CONDUCT COMBAT OPERATIONS IN CB ENVIRONMENT
- TOTAL AIRBASE SYSTEM FOR DEPLOYMENT OF SMOKE AS PASSIVE DEFENSE MEASURE
- HARDENING SYSTEMS/MATERIALS TO PROTECT COMMUNICATION FACILITIES FROM WEAPONS & CBW AND PERMIT UNINTERRUPTED OPERATIONS (ANTENNAS, ELECTRICAL CABLES, WAVE GUIDES, CONTROL TOWER, ETC)

3. TACTICAL SHELTERS

- NEW MATERIALS AND CONCEPTS FOR INNOVATIVE PANEL DESIGNS
- NEW MATERIALS, CONCEPTS AND METHODS TO PROTECT SHELTERS FROM WEAPONS AND EXTREME ENVIRONMENTAL CONDITIONS
- TECHNIQUES TO PROVIDE ELECTROMAGNETIC PULSE PROTECTION

4. FIRE PROTECTION

- AUXILIARY AGENTS THAT ARE CLEAR, EFFECTIVE AND NON-TOXIC FOR ELECTRICAL AND FLOWING FUEL FIRES

- SMALLER, LESS WEIGHT, LONGER LIFE BREATHING SYSTEMS FOR FIREFIGHTERS

5. PAVEMENTS

- RATIONAL FAILURE CRITERIA FOR PAVEMENT SYSTEMS

- IMPROVED METHOD TO INTERPRET DISPERSION CURVES RESULTING FROM WAVE PROPAGATION THROUGH PAVEMENT LAYERS

- RATIONAL DESIGN CRITERIA FOR MIXED TRAFFIC

- OVERLAY DESIGN CRITERIA BASED ON NDT (WAVE PROPAGATION) DATA

- NEW, CHEAP, PAVEMENT SURFACE MATERIALS TO REPLACE ASPHALT

APPENDIX D

Survivability/Vulnerability Research Needs

SURVIVABILITY/VULNERABILITY WORKSHOP

1. The Survivability/Vulnerability Workshop discussed the following general research areas:

a. Free Field Airblast - Maj Gary Ganong

b. Free Field Ground Shock - Mr Steve Melzer

c. Determination of Loads on Structures - Capt Stan Chang

d. Dynamic Structural Response - Lt Joel Bradshaw/ Lt Bob Frank

e. Response of Internal Equipment - Dr M A Plamondon

f. S/V Studies, System Assessment - Capt Tim Webster

Simulation development concerns were also on the agenda, however, time was not available to discuss them. Research needs are included below as Item 2. f.

2. A summary of the research requirements identified for each of the discussion areas is given below:

a. Free Field Airblast:

(1) Precursors - Thermal Layer Definition

(2) Dust - Density Definition

(3) Energy Coupling - Trench-Direct Hit and Near Miss

(4) Blast Wave Attenuation, and Wall/Ablation/Friction Down-Ribbed Reinforced Concrete Trenches

(5) Equations of State for:

Airborne Soil/Dust
Airborne Concrete

b. Free Field Ground Shock:

(1) Material Property Research

two and three phase soil properties
strength degradation
shear properties at high strains
tensile behavior (soil and rock)
relative motion in rock
rate effects in soil

(2) Ground Shock Research:

range limits on elastic wave solutions
strain state in cylindrically and spherically divergent motion conditions

(3) Siting - new geotechnical survey techniques

c. Determination of Loads on Structures:

(1) Structure-Media-Interaction Studies - interface normal pressure and interface shear stresses

d. Dynamic Structural Response

(1) Nonlinear material models for conventional reinforced and fiber reinforced concrete

(2) Concrete shear strength

(3) Improved computer models

higher order elements
3-D inelastic plate element
large displacement capability

(4) Definition of structural failure

e. Response of Internal Equipment:

(1) Input motion environment definition

free field ground shock
rigid body structural motions
flexible structure motions

(2) Feedback effects of equipment

(3) Ideal isolator performance

(4) Real isolator/attachment performance

(5) Coupled motion effects

f. High Energy Simulation

(1) Simulation Devices

extend yield and pressure capabilities to both higher and lower levels
provide wider variety of waveforms
improve quality of HEST (high energy simulation technique) waveforms (higher frequency spikes)
improve characterization of energetic materials

(2) Instrumentation Devices

pore pressure measurements in geologic materials with varying water content
stress measurement instruments and placement in "hard" geologic materials with least possible disturbance of medium
transient pressure data (10 microsecond rise time) to 30k psi
long-span displacement measurements with fast (5 millisecond rise time) response
innovative measurement techniques (indirect means, exotic materials)

3. A recurring comment throughout the workshop was that primary emphasis should be placed on developing new and improved material models (for both the soil media and reinforced concrete) prior to the development of significantly more sophisticated computer techniques.

APPENDIX E

Civil Engineering
R&D Requirements

CIVIL ENGINEERING R&D REQUIREMENTS

A Handout prepared for the AFOSR/FJSRL Symposium on
Air Force Basic Research in Civil Engineering
23-24 February 1078

Presented by:

Lt Col Sterling E Schultz
Director of Environmental Planning
Air Force Civil Engineering Center

This handout itemizes R&D requirements and gives the name of a person whom you can contact to obtain additional information about a requirement.

1. AIRFIELD PAVEMENTS: Major James I Clark, AFCEC/DEMP, (904) 283-2112

a. Develop a Liquid Oxygen (LOX) compatible joint seal material.

b. Develop a new Jet Fuel Resistant (JFR) joint sealant (cold poured) which has a long shelf life to replace current SS-S-200D Type H which has a short shelf life.

c. Develop a cold applied non-JFR joint seal material to replace the old SS-S-195 sealant which has been deleted from the USAF system.

d. Develop definitive criteria for a back stop filler material for use with joint sealants.

e. Develop realistic and scientifically repeatable failure criteria for both rigid and flexible pavements which can be used in further development of pavement evaluation theory and application.

f. Develop an acceptable and effective joint design for pavement transition at rigid/flexible pavement interface.

g. Develop Federal Specifications for epoxy concrete used to repair spalls in PCC pavements.

h. Determine proportion of fly ash to be used in Portland Cement Concrete (PCC) airfield pavements as a replacement for some Portland Cement in the mix.

i. Find a solution to the alkali aggregate problem in PCC.

j. Reach a breakthrough in nondestructive testing techniques for determining structural integrity of airfield pavements.

k. Reverify design and evaluation criteria in use for Marshall properties of asphaltic concrete.

l. Develop maximum criteria for stability of asphaltic concrete for airfield pavements.

m. Develop density requirements for use in mix design of asphaltic concrete pavements.

n. Develop a porous friction surface which is resistant to fuel spills and structural damage from aircraft traffic.

o. Develop a simple but effective system for measurement of requirement to remove rubber from runway surfaces and to measure effectiveness of rubber removal procedures.

p. Develop correlation ratios between aircraft stopping distances and runway surface conditions.

q. Continue development of advanced computer programs for use in the runway roughness evaluation program to correlate pavement roughness with aircraft responses.

2. CORROSION: Mr Thomas F Lewicki, AFCEC/DEMR (904) 283-2114

a. Develop an insulation to prevent corrosion of lead wires in deep well anode beds.

b. Devise a scheme for preventing gas pockets in deep well anode beds.

3. ENERGY REQUIREMENTS: Mr Freddie L Beason, AFCEC/DEMR, (904) 283-2112

a. Develop alternate energy sources for remote Air Force installations.

4. FIRE PHENOMENON: Major Birney T Pease, AFCEC/DOZ, (904) 283-2296

a. Conduct a basic analysis of fire phenomenon to identify, select and evaluate alternative methods of fire suppression and extinguishment.

5. NOISE ASSESSMENT AND PREDICTION CAPABILITY: Captain Gerald L Plummer, AFCEC/DEVC, (904) 283-6228

a. Determine effect of terrain, vegetation, ground cover and man-made structures on aircraft noise propagation.

b. Development of noise data base for Air Force helicopters.

6. ENVIRONMENTAL IMPACT ANALYSIS PROCESS: Mr John E Palmer, AFCEC/DEVP, (904) 283-4207

a. Develop a dynamic socio-economic predictive model.

b. Provide statistical refinements to the Rational Threshold Value (RTV) system.

7. BIRD CONTROL IN THE AIRFIELD ENVIRONMENT: Captain Michael J Harrison, AFCEC/DEVN, (904) 283-2519

a. Conduct studies on bird behavior and bird habitat requirements as related to the airfield environment.

b. Determine the repelling effect of landing lights and flashing strobes on birds.

8. QUALITY OF LIFE: Mr Charles F Lewis, AFCEC/DEVC, (904) 283-6228

a. Identify and quantify the impact of geographic and environmental factors affecting Air Force base livability.

b. Quantify the potential people impacts resulting from new and future Air Force technological applications.

9. PRODUCTIVITY COMMUNICATIONS AND MANAGEMENT: Mr Rene Cooper, AFCEC/DOY, (904) 283-6233

a. Identify means of improving organizational communications and management structures.

b. Define attitude changing factors that foster work oriented attitudes.

c. Identify communication flow-patterns.

d. Develop management techniques for communicating with people at their level of understanding.

e. Model an "ideal" Base Civil Engineering organization.

APPENDIX F

Draft Research Objectives

USAF Academy Colorado
23-24 February 1978

DRAFT RESEARCH OBJECTIVES

USAF BASIC RESEARCH IN CIVIL ENGINEERING - LIVABILITY, PRODUCTIVITY & MANAGEMENT

The USAF mission in civil engineering includes acquisition, construction, maintenance and operation of real property facilities and provision of related management, architectural, engineering and other support work and services. The scope of this mission comprises some 11 million acres, a physical plant with a $49 billion replacement value, 64,600 employees, and an annual budget approaching $3 billion.

In the face of dwindling resources (money, manpower, energy, etc.) and increasing demands, optimal allocation of these resources becomes increasingly important. Improved productivity, mission effectiveness and readiness will continue to rely on the development of new technology through the application of "hard" scientific disciplines. At the same time, advances can be made through efforts in areas such as behavioral science and management theory in order to develop innovative approaches to base management, organizational development and job enrichment, livability, productivity, and readiness.

Productivity-Communication

Fundamental work is needed to define measures of productivity for USAF Engineering and Services work forces, to define the technological and behavioral variables that affect productivity, and to develop simple but effective communication mechanisms which enhance productivity.

Livability-Mission Effectiveness

It has been hypothesized that "mission effectiveness is dependent on morale, motivation and productivity which are functions of base livability and the management environment."* In order to validate this hypothesis and translate it into workable policy and management practice, research is needed to define the concept of livability and

* Henriksen, L H and Vest, G D, "Mission Effectiveness and Base Livability," Engineering and Services Quarterly, November 1976

its relationship to mission effectiveness in a quantitative/operational framework. In order to allocate resources optimally, new knowledge is required which relates state of repair, quality of services and working/living environment to readiness and productivity. Assessment techniques are required in order to identify critical areas of concern for further study.

Management Software

Operations research and systems engineering efforts are needed to develop innovative management tools with cost-effective applications in several areas:

a. Supply support and management

(1) Inventory control

(2) Central stores vs local procurement

(3) Source selection as a function of location, transportation and manpower

(4) Decreased rate of high-priority requisitions

b. Control and management of recurring work

(1) Work requirement validation

(2) Decision criteria for maintenance/repair schedules

c. Work identification and planning

(1) Long-term forecasting and resource allocation

(2) Smoothing techniques

(3) Engineering performance standards

(4) Work scheduling and production control

(5) Manpower scheduling and forecasting

USAF Academy Colorado
23-24 February 1978

DRAFT RESEARCH OBJECTIVES

USAF BASIC RESEARCH IN CIVIL ENGINEERING ENVIRONMENTAL PROTECTION

In order to maintain readiness and mission effectiveness while complying with environmental protection requirements and minimizing adverse impacts, it is necessary to establish a sound scientific basis for evaluating the environmental effects of Air Force activities. Research is required to investigate, understand and model the phenomena underlying the generation, transport and control of Air Force unique pollutants and the socio-economic consequences of changes in base missions.

Detection, Monitoring and Control

Research is needed to develop improved (rapid, sensitive, reliable, accurate and/or cost effective) techniques for detection, quantification and surveillance of environmental contaminants, noise, aircraft engine or ground source emissions, and ambient concentrations. Techniques which do not interfere with operating characteristics of the pollution source are of special interest. Both hardware and computer software developments are needed for real time sampling in the aqueous, terrestrial and atmospheric environments.

Transport and Impact Mechanisms

Research is needed to determine and model the environmental fate of Air Force pollutants and the effects of Air Force operations on both the physical and socio-economic environments.

Pollution impacts include the effects of turbine/rocket engine emissions, stationary ground source emissions, accidental releases of toxic materials during transport/handling/storage, fuel dumping, photochemical effects and airbase ground transportation activities.

Improved models for assessing impacts on air and water quality, air pollution effects on water/soil, and high noise levels are of interest. Socio-economic impact models are needed which account for the dynamic time-wise effects of base closings or mission changes on the local culture and economy, and for community response to Air Force operations over the short and long runs.

Research in the areas of environmental transport and impact mechanisms should pay attention to the need for realistic standards for emission/effluent levels and for other effects. Better knowledge of the behavior of these pollutants may call for the relaxing of standards which are overly stringent due to insufficient knowledge.

Disposal, Abatement and Resource Recovery

These objectives are driven by the dual requirements for compliance with environmental standards and for conservation of materials, energy and effort. Research is needed to uncover new and better ways to recycle particular effluents and to model the costs and benefits of such efforts.

Research is needed to mitigate the effects of pollutants from Air Force operations, including control of turbine engine test cell emissions and of HC emissions from fuel storage tanks. Emissions included gases, particulates, aerosols, noise and smoke, which may be controlled through fuel additives, injection mechanisms, engine redesign and other initiatives. Certain environmentally harmful or hazardous wastes unique to the Air Force will require special efforts for control and abatement (e. g. byproducts of hydrazine manufacture, wastes from paint stripping, and aqueous film forming foams used in firefighting).

Environmental Management and Planning

In order to use environmental protection R&D results planners and managers need comprehensive impact assessment models and planning systems, management information systems, natural resource management systems, and environmental management standards. Current state-of-the-art is adequate for most of these needs, requiring a development or technology transfer effort rather than basic research.

Further basic research may be required to facilitate prevention of bird-aircraft strike hazards. New knowledge is required to 1) design airfield layouts and land-use patterns, 2) to change roosting and/or bird flight patterns, and 3) to detect and track birds in flight. Also, techniques are required to control pest birds from interfering with the maintenance and operation of certain ground facilities.

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DRAFT RESEARCH OBJECTIVES

USAF BASIC RESEARCH IN CIVIL ENGINEERING
GENERAL CIVIL ENGINEERING

Airfield Pavements - Bomb Damage Repair

To improve airbase survivability/vulnerability, efforts are underway to enable recovery of bomb-damaged runways in the shortest possible time in order to resume aircraft operations after attack. Basic research is needed to identify and characterize materials, equipment and methods which will allow rapid clearing of unexploded ordnance, removal of debris and heaved pavement, selection of the optimum location for a contingency runway and rapid repair of craters ranging in size from large to small.

Capping materials are needed which are easily emplaced and which cure rapidly to the necessary strength and durability. Analytical techniques and computer models are needed in order to evaluate the influence of runway roughness on aircraft performance and pavement life.

Research is needed to understand the behavior of runway mats under landing/takeoff loads, with particular regard to anchorage requirements and the phenomenon of a wave which forms in the mat and is propagated ahead of the rolling landing gear. Also, analytical tools are required to allow prediction of bomb-damage parameters (crater dimensions, debris deposition) as a function of pavement system properties and ordnance descriptors.

Airfield Pavements - Design, Construction and Maintenance

Research is needed to develop analytical models to predict the structural and functional behavior of pavement systems in terms of system characteristics, traffic loads and environmental factors. New knowledge of the constitutive properties of pavement systems and the processes by which pavements fail or become unserviceable is required, from the perspective of fundamentals underlying the phenomena in question rather than empirically.

Models are required to evaluate the effectiveness of pavement overlays on the serviceability or durability of existing pavements, under wheel loads due to new aircraft or mission profiles. Reflection cracking in overlays and D-cracking at joints and edges are recurrent problems which call for new understanding to enable improved pavement life and serviceability. New materials are contemplated which will require new design criteria, construction methods and analysis models.

New approaches to nondestructive evaluation of pavement structural capability are needed which are rapid, inexpensive and reliable, and which minimize interference with aircraft operations. Improved methods of measuring surface roughness, slope and skid resistance are also required. Improved materials and construction methods are needed for pavement maintenance, and benefit cost models are needed to enable optimal allocation of maintenance resources and to minimize life cycle costs.

Analytical efforts are needed to model the dynamic interaction of aircraft and runway, considering both as flexible systems and accounting for the effects of each on the other, with particular regard to the deteriorating effects of this interaction on the pavement system.

Airbase Survivability and Vulnerability

Although the R&D program in air-mobile shelters has matured, certain research efforts may lead to substantial improvements. New materials and/or fabrication techniques can lead to improved cost effectiveness. Advances are needed to improve hardness to RFI/EMI effects, CBW effects, thermal effects, and weapons effects. Especially needed are shelters or revetments hardened to other effects but transparent to communications signals.

Corrosion Control

Also, a mature R&D effort, further advances in corrosion protection could nevertheless lead to considerable cost savings and prevent lapses in readiness and mission effectiveness. Improved corrosion resistant coatings, improved splicing techniques for underground/hardened cables, and improved instrumentation to monitor cathodic protection systems or to detect corrosion problems are needed. The failure mechanism of deepwell anodes in existing cathodic protection systems requires new understanding.

Energy Conservation

Basic research efforts are not required in this area. Rather, application of existing technology is required to cope with fuel shortages and conservation requirements.

Equipment and Systems

In crash rescue/fire protection, improvements are desired in equipment (turret and nozzle design), protective clothing which includes breathing and communication systems, fuel adsorption materials, magnesium fire control agents, and smoke abatement techniques for training fires.

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DRAFT RESEARCH OBJECTIVES

USAF BASIC RESEARCH IN CIVIL ENGINEERING
NUCLEAR WEAPONS EFFECTS ANALYSIS

Analysis of the survivability/vulnerability of future strategic weapons systems requires new knowledge in order to minimize uncertainties in the areas of technical feasibility, performance and cost.

The MX system, for example, would comprise a large number of missile launch points (in shallow trenches or surface shelters located in alluvial valleys rather than in hard rock), with relatively few of the launch points actually occupied by missiles. The system configuration, the geophysical environment, and the importance of marginal improvements in emplacement costs call for research efforts in several areas.

Geotechnical Survey Techniques

Research is needed to provide rapid, reliable and cost-effective methods of site investigation, particularly in alluvial valleys. The objective is to acquire engineering and geologic data that determine NWE analysis parameters, system survivability/vulnerability, construction methods, costs and causes for site exclusion. Advances in data acquisition, reduction, management and display are also required.

Soil/Rock Dynamics Models

Better constitutive properties and behavior models are needed in order to more accurately characterize the dynamic response of geologic media to blast/shock loadings, especially for alluvial materials, layered materials, partially saturated soils, cemented soils and fractured rock.

Improved models for nonlinear soil/rock dynamics are required to predict peak values and waveform characteristics for ground motions, in-situ stresses, seismic effects and stress attenuation with depth or range. Direct-induced, air-induced and crater-induced effects will require assessment. Analytical models should be correlated with results of simulation events to verify accuracy and credibility.

Newer approaches, including probabilistic material mechanics, three-phase material models, micro-analysis of failure zones, discrete particle models, and innovative applications of elasto-plastic, hysteretic and hydrodynamic models need to be explored.

Cratering and Debris Phenomena

Research is needed to provide analytical models which can predict crater volumes and dimensions, crater-induced ground motions and ejecta patterns for a variety of geologies and weapons parameters.

Structural Response Models

Research is needed to develop models and transfer functions for stress, displacement, velocity and acceleration at the structure-medium interface. SMI models are required which allow for discontinuous displacement fields at the interface and which account for separation phenomena.

Models are needed which use probabilistic mechanics and failure theories to develop survivability/vulnerability statistics from probability models of threat, transfer functions and fragility curves. Inelastic plate/shell elements compatible with existing codes need further development, testing and validation. Simplified analytical models need to be derived through empirical interpretation of computer analysis results. Constitutive models for plain and fiber-reinforced concrete are needed which account for post-yield behavior and failure mechanisms.

New understanding is required to account for several phenomena peculiar to the MX configuration. The in-trench NWE environment includes shock/blast enhancement by energy channelization or confinement, tunnel roof venting or collapse, wall drag effects, blast plug reflection effects, debris effects, effects of construction details and structural configurations and enhancement of overpressures due to raised earthwork berms. The relationships among backfill method, degree of compaction and SMI or energy transfer require further study. Analysis methods and design criteria for shock isolation and rattlespace requirements need improvement.

Construction Technology

The unique nature and repetitive character of contemplated systems calls for basic research to develop construction capabilities which will enhance the performance and reduce the cost of these systems. The lack of experience with fiber-reinforced concrete requires study to develop design criteria and optimum construction methods.

A critical parameter in the MX concept is the backfill. New knowledge is required to assess the tradeoff between cost of compaction and enhanced hardness. Also, the MX concept may require backfilling at near-zero water content, and the parameters governing compaction of dry soils is not well developed.

Simulation Technology

Advances in explosives technology require development of analytical models for explosives characterization and development of cheaper, safer and more reliable energetic materials.

Improvements in measurement and data acquisition/management technology are necessary to determine time histories of material properties, stresses and motions, both in extremes of magnitude or periodicity of measured effect and in hostile environments (debris, explosive shock, temperature, etc). Data acquisition/storage/retrieval/reduction systems are needed, as is improved equipment for calibration and evaluation of the primary instrumentation.

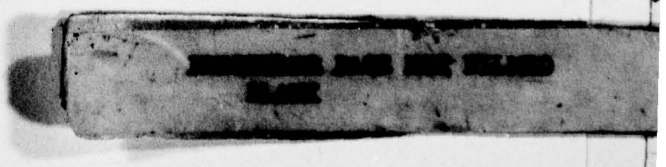
Deep Basing Technology Issues

Potential systems call for missiles sited at great depths in rock formations with advantageous attenuation characteristics. Launching these requires post-attack digout, either horizontally if mesa or canyon sites are identified, or vertically otherwise.

Technical feasibility requires an egress mechanism which will perform reliably under difficult conditions. Research is required to define the post-attack geologic environment, including the extent and properties of the crater rupture region, and the extent of block earth movements which might close off preconstructed exits. Reliable egress will require advances in the state-of-the-art of boring/tunneling technology. Efforts are needed to develop a range of solutions for manned and unmanned excavation for vertical and horizontal egress, for muck removal, and to evaluate the speed, reliability and cost of potential egress systems.

APPENDIX G

Productivity-Livability Workshop Summaries



OUTLINE

PRODUCTIVITY/LIVABILITY

- Closely related to each other and to Mission Effectiveness

- Livability part of productivity

- Define Productivity

  "Output per manhour relative to input, quality considered"

  We input resources and work requirements

  Our output is a service - maintenance, repair, construction, demolition and professional service

  Output results from all factors of production - labor, management, money, machines, raw materials, etc

- Variables which have greatest impact on productivity

  Technological development

    Material acquisition system, machines, equipment, planning, programming, scheduling procedures used for work accomplishment

  Job Performance

    Two main factors

      Ability or competence (experience, training, personality, etc)

      Motivation - needs, objectives, communication

- Ways to measure Productivity

  Must develop an index instead of a measurement since some or most of the variables that affect productivity are unquantifiable

  (1) Measure of effectiveness - the extent to which the goals and objectives of the service are being met

  (2) Measure of efficiency - relate the amount of a service output produced to the amount of input required to produce it

  (3) Measures of workload performed - measure tons of waste, acres mowed, square feet painted, etc

- We have some background in productivity and livability

  Most of us know Maslov's theory

- We have an IE program

- We have done some things ourselves in livability - (programming form)

Interdisciplinary Communications Program - Smithsonian Institute
ICA says we must increase effective communication in order to increase productivity

WORKSHOP

PRODUCTIVITY

Discussed base level operating procedures and responsibilities - how we do our business in Civil Engineering at base level

Changes in procedures could/should improve productivity

Currently we are 50% productive - we think we can measure the lack of productivity

Difficult to measure productivity itself

- Need to define the variables that affect productivity

We know livability is one - motivation is another

Lengthy discussion on motivation

What motivates - who motivates

- Need to determine means of measuring productivity

Maybe not as square feet of wall painted - gallons of sewage processed

But satisfaction - efficiency, quality

Indexes may be appropriate

COMMUNICATION

The size of our organization (90,000 including Services)
Its components

Increase Productivity by improved communication from MACRO level to MICRO level

Need investigation into improved communications

OUTLINE

LIVABILITY

- Comprised of

  Work 8-10 hours
  Transportation 1/2-2 hours
  Leisure - everything else - discretionary time

- Shopping/Community Centers are being looked at now

- New recreational parks have been developed - we need them

- Environmental, health, natural resources programs are expanding

- What can we in CE do to improve livability?

- Quality of life factors ranked in 1971 and 1973 at EPA conferences

- Dr Harry Caldwell has developed his own ranking factors (1977)

- We don't live in barracks anymore - dormitories

- We don't eat in mess halls - dining halls

  Dorms - carpets, accent walls, modular furniture, color coordinated curtains, carpet, furniture, bed covers

  Dining Halls - carpets, dimmer lights, varying decor, beer dispenser, fountain bars, salad bars, etc

WORKSHOP

LIVABILITY

We in Civil Engineering and Services have limited power, responsibility

Can support Social Action Programs, Boy Scouts, Intramural Sports, etc

Majority of our impact is in physical facility, design and to a large extent, the interior decoration

Limited number of construction projects - large volume of interior design

We need to find out the livability concerns of our people

- Need to determine the environmentally limiting livability aspects of design - location, weather, separation

- Need a research hunt to determine what is already available that pertains to the Air Force Civil Engineer. Then a package to communicate this to our people

- Need decision criteria for senior managers to determine the correct livability decisions

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